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ESD-TR-75-301, Volume I

MTR-3067, Volume I

ON-LINE VEHICLE MAINTENANCE DATA MANAGEMENT:
SUMMARY

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AIR FORCE SYSTEMS COMMAND

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Hanscom Air Force Base, Bedford, Massachusetts



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model. Their comments, together with the model specification, form a requirements and design base for an operational prototype system.

Volume II presents the model specification and test results, Volume III documents model software and data base, Volume IV presents prototype development guidelines, and Volume I summarizes these same topics.

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SECTION I

INTRODUCTION

SUMMARY

In accomplishing its mission, the Air Force operates and maintains a \$2 billion fleet of 100,000 ground vehicles at some 500 sites around the world. The services of more than 8,500 officer, airman, and civilian maintenance specialists are needed to keep this fleet in readiness.

A significant segment of this work force spends much of its time collecting, evaluating, and disseminating maintenance management data, aided today by the Vehicle Integrated Management System (VIMS). A standard base-level system, VIMS processes vehicle maintenance data in daily batches on the Burroughs B3500 computer: the daily, weekly, and monthly reports it produces support the management function at both the maintenance squadron and higher headquarters levels.

As developer of VIMS software and procedures, the Directorate of Logistics at the Air Force Data Systems Design Center requested in FY74 that ESD/MITRE conduct a brief analysis of the system to uncover possible alternative techniques for improved handling of maintenance data. (Results are reported in ESD-TR-75-1, "Air Force Vehicle Integrated Management System Data Handling Study.") A primary conclusion of the study was that the maintenance management function could benefit from on-line access to VIMS. This verdict delivered, the study group was subsequently asked to undertake an FY75 effort to collect sufficient data on which to base an AFDSDC decision as to whether or not to proceed with development of a prototype on-line VIMS. The study group was also tasked to provide system development guidelines should an affirmative decision be made. The four volumes of ESD-TR-75-301 report the results of these studies.

The work proceeded in several overlapping phases: A transaction-oriented, man/machine interface (on-line language and scenarios) was designed; this transactional specification was transformed into a set of minicomputer software specifications, and

a model* on-line VIMS was developed to operate on the Nova 800 computer in ESD/MITRE's Data Handling Applications Center; prototype on-line VIMS development guidelines were formulated; functional personnel (prospective on-line VIMS users drawn from vehicle maintenance activities) were recruited from the field to work with the model, and their comments, in combination with the transactional specification, form the basis of a revised system specification.

After hands-on experience with the model, functional personnel agreed that on-line access to VIMS would

- improve both accuracy and currency of maintenance data,
- speed execution of currently manual tasks, and
- maximize efficiency of personnel by converting time spent at repetitive clerical work into valuable extra hours of management and analytical activity.

Without doubt, the key factor in the model's enthusiastic acceptance by prospective users was the natural way it assumed its role within an envelope of familiar procedures, eliminating many manual record keeping tasks, yet leaving undisturbed the current "ways of doing business" and the prerogatives of the individual specialist.

Volume II of this series details the model specifications, test procedures and results, Volume III documents model software and data files, Volume IV presents prototype development guidelines, and this volume (I) covers these same subjects in highly compressed form. The remainder of this section summarizes the current maintenance data management environment as supported by batch mode VIMS, and outlines the conduct of the model development and evaluation project.

*Note: It is important to recognize the distinction between model and prototype. The model was built to simulate the external representation of an operational system for prospective users, to gain an appreciation of how an on-line system might best be assimilated into the vehicle maintenance environment. Simulation of external characteristics does not require use of a number of processing steps and files needed to support an operational system. If a prototype is developed, it would represent the first installation of what would eventually become more than 100 similar systems supporting vehicle maintenance throughout the Air Force.

CURRENT VEHICLE MAINTENANCE DATA MANAGEMENT

An estimated 75% of all Air Force vehicles are brought to maintenance facilities at least once a month, either for scheduled preventive maintenance or for unscheduled repair. Maintenance operations at most major facilities are coordinated by a group of four to seven specialists assigned to the Maintenance Control work center. (See Figure 1.) Personnel assigned to Workload Control screen and classify maintenance problems, prepare work orders for execution by the shops, schedule workloads into the shops, and maintain status on work in progress. The Materiel Control function is concerned with the acquisition and issuance of replacement parts.

Under direct control of the Base Transportation Officer, the Reports and Analysis section (R&A) is the focal point of the maintenance data flow network (See Figure 2.), and is the primary paper work interface between the maintenance organization and the current VIMS system. For example, R&A collects work order, parts, gasoline, and manhour data from Maintenance Control and the shops, provides the keypunching services needed to create input for the VIMS daily run, and monitors and distributes VIMS outputs (vehicle and maintenance status listings). As well, it furnishes the Maintenance Officer with management data identifying trends in maintenance costs, personnel performance, vehicle down time, and similar indicators.

As with any data system, incorrect or incomplete VIMS inputs from work or control centers result in the generation of inaccurate or late reports, which in turn can damage the credibility of the system and tempt users to institute various manual record keeping schemes as a back-up measure. Additionally, given VIMS's current end-of-day processing orientation, there are built-in delays which often prevent correction of erroneous files and reports until several days after incorrect inputs have been detected by the system.

Based on these observations, the notion of providing on-line access to the VIMS system appeared attractive immediately, because:

- Input data could be screened by system edit software at input time, with discrepancies called to the user's attention immediately.
- Much of the fixed information required to formulate a VIMS transaction could be supplied directly from system files and be displayed at the user's on-line terminal, saving considerable manual retranscription with a consequent reduction in the probability of transcription errors.

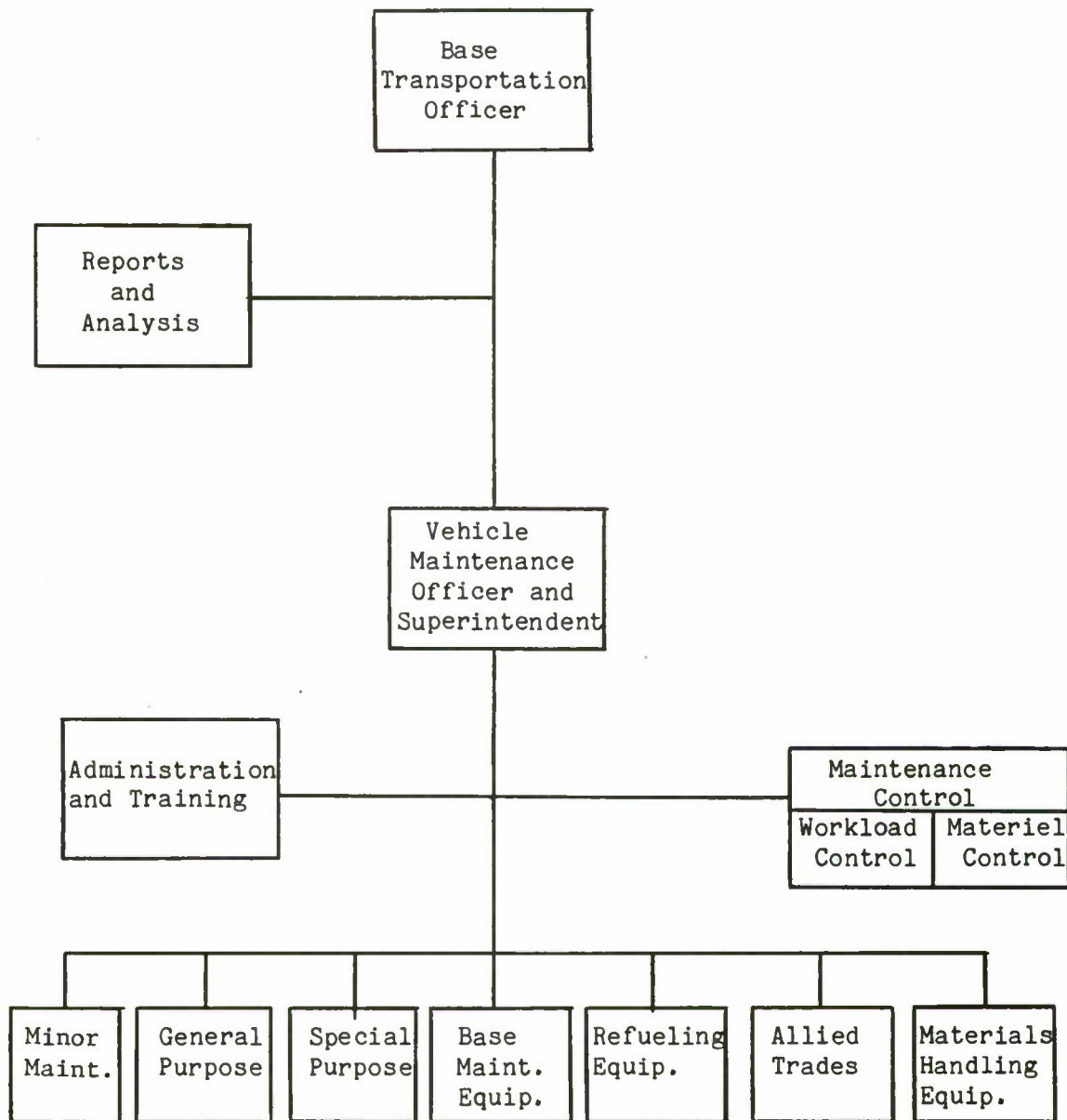


Figure 1. Vehicle Maintenance Organization

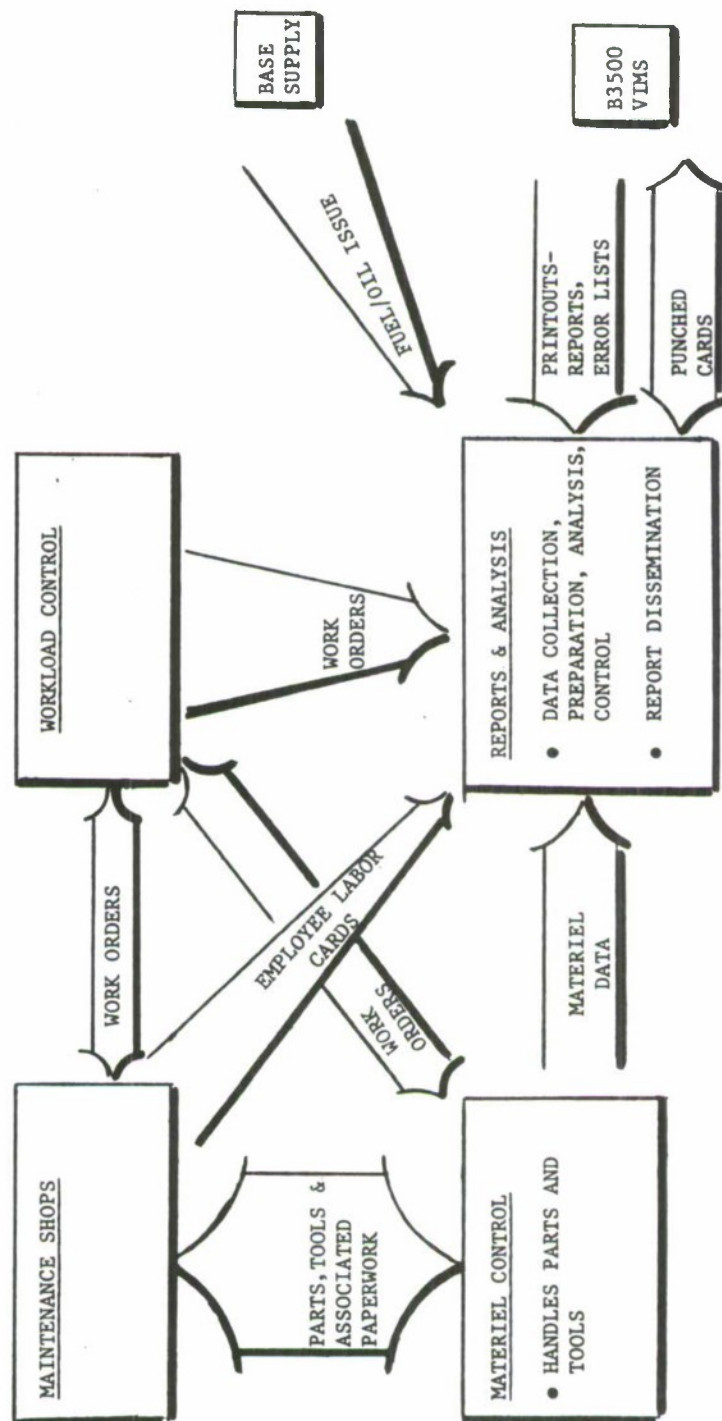


Figure 2. Summary: Base-Level Vehicle Maintenance Data Flows

- With the ability to update files directly and immediately in response to on-going maintenance events, on-line access could guarantee upgraded currency of vehicle and work-in-progress status information.
- Providing a two-way dialogue during transaction formulation, an on-line system could prompt the user through all applicable input and decision steps, noting omissions of mandatory items, and bringing attention to optional steps which the user might otherwise ignore (a check on possible repetitive repair of a particular vehicle component, for example).

Aware of the potential value of these kinds of capabilities, the study group planned and executed the model development and evaluation project as outlined below.

CONDUCT OF THE PROJECT

Figure 3 summarizes the relationships among the project tasks. An extensive observation and analysis of current maintenance data management techniques (based on the current VIMS system) was conducted during FY74, yielding a description of the baseline (batch) system which was validated by AFDSDC. Building upon this, the study group identified particular phases of maintenance data management which could profit from on-line support, and wrote a preliminary system specification in the form of a set of transactional scenarios. (Opening a work order, or issuing a part, for example). Each scenario was designed primarily around the source documents and procedures of the current system, with a cathode ray tube display/keyboard and video facsimiles of familiar forms replacing the user's pencil and paper. (This conservative design approach was carried over into the implementation of the model, and became the single strongest factor behind its rapid acceptance by functional personnel).

While one segment of the study group translated the preliminary specification into a set of software requirements for the model system, another segment addressed the prototype development planning process, identifying prototype hardware/software options, design concepts, preliminary performance projections, and development planning tasks and schedules. (The work is presented in Volume IV of this series).

The model system was implemented on a Data General minicomputer (Nova 800) with a Cathode Ray Tube (CRT)/keyboard terminal manufactured by Delta Data Systems (Telterm 5200) operating at 2400 bps.

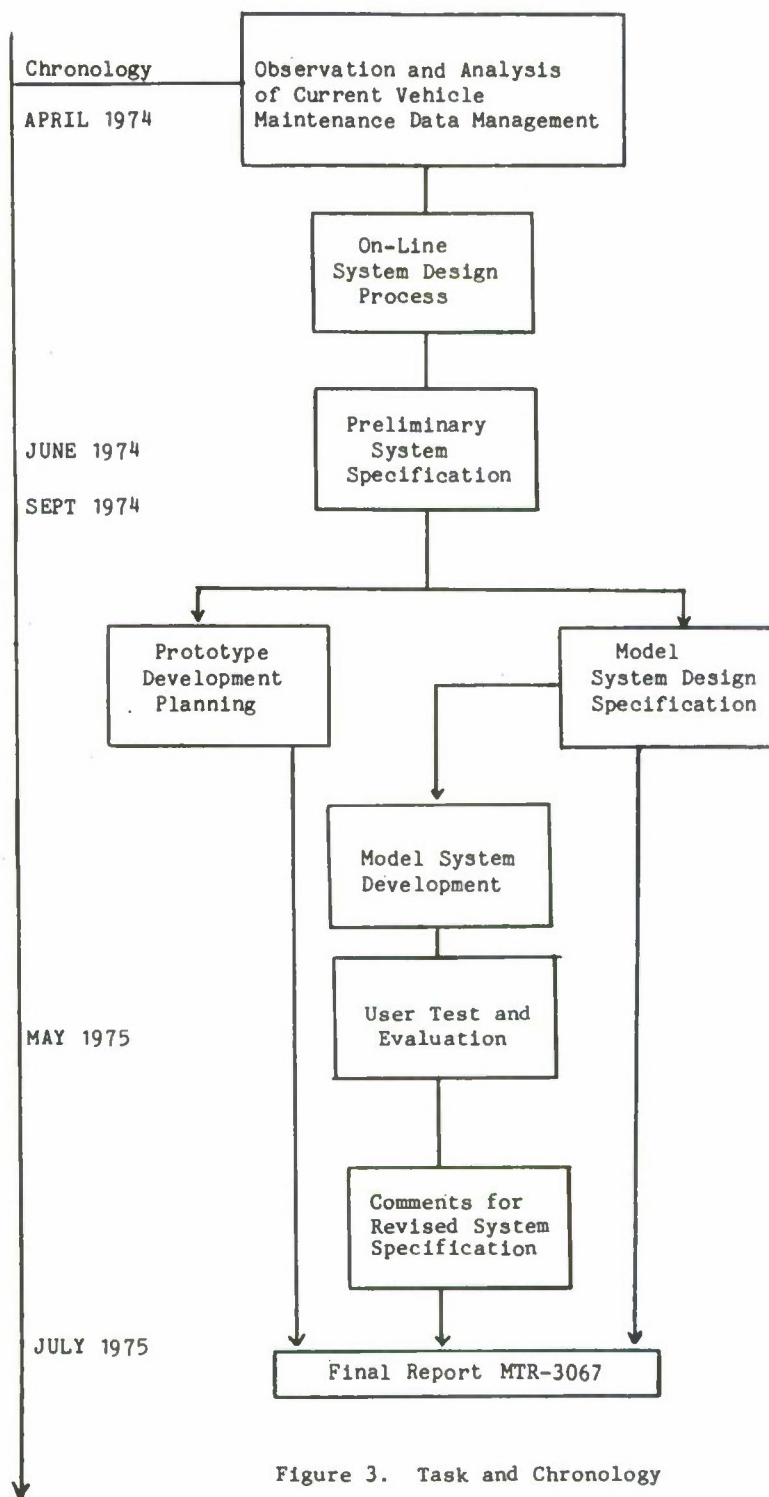


Figure 3. Task and Chronology

Figure 4 shows the terminal screen and keyboard. (The keyboard resembles that of a conventional typewriter with the addition of a duplicate set of numeric keys grouped together in the fashion of a standard calculator. Additionally, a set of special function keys is provided for screen cursor movement and for transmission of non-data signals to the system: transaction complete, input line complete, line cancel, etc.)

Use of a CRT/keyboard as the primary user input/output device was another conservative design decision which was proven correct during model test and evaluation. The need for more exotic data capture technology has yet to be established for the application, although future experiments might establish a need. Badge readers and similar terminals could be used within the shops for job tracking, for example. In most instances today, however, supervisors have adequate knowledge of job status. In addition, resistance to such close time-keeping could be expected where not even time-clocks are in common use. The U. S. Department of Transportation's National Highway Safety Transportation Administration is reportedly conducting an extensive investigation of the costs and benefits of using advanced automated diagnostic tests, with results to be available during 1977. (Computerworld, 5 March 1975, page 32.) These results can help the Air Force decide how to proceed with such techniques.

The design and interrelationships of the model's software modules and data files are described in Volume III of this series. With the on-line VIMS model in operation, both study group and functional personnel exercised the transactional scenarios specified earlier, providing useful comments on the preliminary system specification (presented with the test and evaluation procedures in Volume II of this series). Three groups of functional personnel spent one week each performing model test and evaluation. In each group were representatives from Workload Control, Materiel Control, and Reports and Analysis, and a wide range of commands was represented: SAC, AFSC, USAFE, TAC, and MAC. In all, ten functional personnel interacted with the model during the test and evaluation phase, providing design guidance based on a total of 155 years of Air Force maintenance experience.

Not only were these prospective users' specific suggestions valuable in refining the system's man/machine interfaces, they also confirmed the previously suspected value of a basic on-line capability. Typical comments gathered during debriefing sessions included the following:



Figure 4. On-Line Terminal

- "...bringing errors to your attention immediately will save time and manhours,"
- "...less chance of paperwork being lost or mislaid,"
- "...it will move most of the input to its source...and give R&A more time to do their real job."

Looking beyond the immediate success of the on-line VIMS model test and evaluation, both project staff and functional personnel agreed that the system modeling approach in general holds great promise for the future. A working model of an on-line system, developed quickly at no great cost, is the most efficient means to gather the professional reactions of the specialists who will ultimately use the system: the sooner these reactions can be factored into the system design, the greater the chance that the system will succeed in the field.

SECTION II

ON-LINE VIMS MODEL TEST AND EVALUATION

SUMMARY

The primary result of model testing was the capture of a large number of specific comments and suggestions from prospective users that will serve as guidance for any subsequent development of on-line VIMS.

Acceptance of the on-line approach was uniformly high among all ten test subjects because 1) current manual procedures were strongly paralleled in the on-line procedures, 2) the on-line procedures provided some immediate and apparent benefits to the user, and 3) the model design allowed the user to feel comfortably in control of the computer.

It was concluded that the development and testing of a model by functional personnel is a highly effective approach to system design.

THE MODEL AND THE TEST ENVIRONMENT

The model is composed of a set of computer programs that respond to and interact with a user as he performs a variety of on-line VIMS transactions, initiated and controlled from a CRT terminal. The modeled transactions represent procedures that would be followed at terminals located in the three work centers mentioned previously; Workload Control, Materiel Control, and R&A. In addition to the CRT terminal, a printer would be available to each work center to obtain immediate hard copy as needed.

The model software was written in ALGOL for the Data General NOVA minicomputer at the ESD/MITRE Data Handling Applications Center. The Center supports a NOVA 800 with 32,768 words of 16-bit core memory, and a large selection of peripheral devices running under Data General's Real-time Disk Operating System. (Volume III of this series presents detailed descriptions of the model's hardware and software components.)

The seven files making up the model's test data base were configured to reflect the typical maintenance status of a fleet of 100 vehicles. The content and structure of the files were selected for expediency in developing the model, and do not represent the content or structure of the files that would be required for a prototype system. Thus the test files contain only a subset of the

data required for a prototype, and are maintained and updated by the model only to the extent necessary to preserve the realism and integrity of the transaction modules as viewed by a user at a terminal.

The files developed for the model include:

- a. VEHICLE MASTER. Contains data for 100 vehicles. Includes static data for each vehicle and complete scheduled maintenance data. (This file was created using actual data for 100 vehicles from the fleet at Hanscom AFB).
- b. VEHICLE HISTORICAL REPAIR. Contains maintenance repair history for 100 vehicles over six months.
- c. EMPLOYEE MASTER. Contains employee name, SSAN, and assigned work center for 30 employees.
- d. HIGH COST BENCH STOCK. Contains FSN's, cost, charge codes and descriptions of 120 high cost bench stock items (taken from HCBS file at Hanscom AFB).
- e. WORK ORDER. Contains copies of all work orders currently open, suspended, or closed less than six days (the file was initially loaded with 32 work orders, simulating two days of activity).
- f. DEFERRED MAINTENANCE. Contains a record of all jobs either deferred or suspended (the file was loaded with 26 jobs, deferred against 20 vehicles).
- g. BACK-ORDERED PARTS. Contains data on all parts on order, or back-ordered and received but not yet installed (the file was loaded with data for 31 parts, ordered against 22 jobs).
- h. PARTS WARRANTY. Contains data on all parts installed on fleet vehicles for which a special warranty is still current (the file was loaded with 36 warranty items).

The proposed on-line VIMS transactions do not represent a major departure from the current batch-oriented VIMS procedures: the transactions are generally designed to assist with specific tasks presently performed at the work centers in the vehicle maintenance area.

The testing with functional personnel was intended to determine if the on-line procedures as specified and modeled could permit users to properly complete their tasks, and whether on-line dialogues, visual display formats and content, and data entry conventions were operationally acceptable.

The following transactions were incorporated in the model:

- a. OPEN. Used to open a work order.
- b. RESUME. Used to resume opening a work order temporarily suspended.
- c. AMEND. Used to retrieve an open work order for review and/or amendment.
- d. VDP/ON. Suspend a work order and put vehicle on VDP (vehicle down for parts) status.
- e. VDP/OFF. Remove a vehicle from VDP status, and reactivate a work order.
- f. CLOSE. Close a work order and report disposition of all jobs.
- g. WO/REVIEW. Display status of all work orders.
- h. DEFER/ADD (CHANGE)(DELETE). Used to make direct additions, changes and deletions to the deferred maintenance file.
- i. PARTS/REVIEW. Display back-ordered parts file.
- j. PARTS/ADD (CHANGE)(DELETE). Used to make additions, changes and deletions to the back-ordered parts file.
- k. PARTS/ISSUE. Issue parts out of the back-ordered parts file against a work order.
- l. HCBS/REVIEW. Display high cost bench stock file.
- m. HCBS/ADD (CHANGE)(DELETE). Used to add, change or delete items from the high cost bench stock master file.
- n. HCBS/ISSUE. Issue high cost bench stock items against work orders.

- o. COPARS. Used to process COPARS (Contractor Operated Parts Store) sales slips.
- p. FUEL. Process fuel/oil issue slips.
- q. TIME/INPUT (EDIT). Process employee time cards, and process error suspense file generated during TIME/INPUT.

Figure 5 is one example of the kinds of formats provided at the terminal to aid the model user in completing transaction input. The format shown is used to accomplish a work order OPEN and contains data describing six maintenance jobs.

USER TEST AND EVALUATION

Table I summarizes the composition of the three teams of functional personnel which exercised the on-line VIMS model during April of 1975.

When each team arrived it was given about an hour of introductory discussion. Field personnel were assured that they were not being tested or evaluated in any way. It was emphasized that they were to help evaluate a proposed system in its early development stage, and that their comments would provide guidance that would help to shape the final system when and if it were to be implemented.

Subjects were introduced to the concept of on-line VIMS and the nature of the model was explained. The model was described as a "fast file clerk," able to perform many routine clerical tasks rapidly and consistently. It was emphasized that the operator of the CRT was always in control, and always retained the decision-making prerogative; the "file clerk" was there to assist only as directed.

Two observers (a MITRE technical staff member and a representative of AFDSDC) recorded comments throughout the introductory, training and testing periods. At any time during testing, specific points were addressed and talked through as they came up.

The subjects themselves also wrote their own comments during the discussion periods, during testing (when they were acting as observers), and during off hours. Each subject also filled out an evaluation questionnaire at the completion of the testing.

WORK ORDER NO (4226) VEHICLE REG NO(69B01922) DATE OPENED(74327) TIME(0806)
 MGT CODE(B204) MAKE/TYPE(P-U CHE) DATE COMPLETED() TIME()
 R/D CODE() MILEAGE EXCEEDED() AGE EXCEEDED()
 PRIORITY(Y) MILES/HR(064230) USER PHONE(4782) WORK ORDER TYPE(F)

ACTN	JOB	SYS	WORK	JOB	DESCRIPTION	MATL	STD
CODE	NO.	CODE	OPR	CTR		COST	HR
(A/	01	(361)	(O)	(220)	(OIL CHANGE	()	(0.5)
(A/	02	(371)	(O)	(220)	(OIL FILTER CHANGE	()	(0.5)
(A/	03	(098)	(M)	(230)	(REPLACE WATER PUMP & THERMOSTAT	(20)	(2.0)
(A/	04	(037)	(M)	(230)	(REPLACE RT HD LIGHT	(3)	(0.5)
(A/	05	(080)	(M)	(230)	(CHECK EXHAUST SYSTEM FOR LEAKS	()	(0.5)
(A/	06	(084)	(M)	(230)	(REPLACE MUFFLER	(30)	(1.5)
(/	07	()	()	()		()	()
(/	08	()	()	()		()	()

REPAIR ESTIMATES:

LABOR COST(\$	20)
INDIRECT COST(12)
MATERIAL COST(63)
EST TOTAL COST(\$	85)

(ONE-TIME REPAIR LIMIT = \$ 159)

Figure 5. Work Order as Initially Displayed During OPEN

TABLE I

Test Subjects: Duty Station, Work Center Assignment,
Air Force Experience and Test Team Assignment

	ASSIGNED DUTY STATION WORK CENTER	Workload Control	Material Control	Reports & Analysis
TEAM 1 3 days	Hanscom - AFSC	X (32)	X (28)	X (15)
TEAM 2 5 days	Shaw- TAC	X (7)		
	Langley- TAC		X (3.5)	X (20)
TEAM 3 4 days	Hahn- USAFE	X (6.5)		
	Dover- MAC			X (20)
	Pease- SAC	X (16)	X (7)	

(): No. of Years Air Force Experience

An oral debriefing was conducted with each team at the end of its test period. These debriefing sessions were tape recorded and the tapes were given to the AFSDC representative.

Almost 400 comments were recorded. These were numbered, sorted and categorized, primarily by the transaction to which they pertained, and further sorted by sub-category within transaction. A separate category was created for comments regarding the CRT/keyboard and for requests and suggestions regarding special reports and inquiries. These comments represent a large volume of specific guidance that could serve as input to the development of specifications for a prototype on-line VIMS. Volume II of this series presents both the procedural details of each transaction and the reactions of the field personnel to them.

In general, acceptance of the model system by functional personnel was surprisingly good. In retrospect it appears that the following factors were responsible:

a. The proposed on-line capability does not represent a major departure from current procedure. The user's terminal primarily assists him in completing tasks which he is already performing in the manual system. As a result, there is a strong parallel between present and proposed methods.

b. In addition to keeping vehicle maintenance management data more current and accurate, the transactions generally offer some direct and immediate benefits to the user, such as fast file retrievals, automatic calculations, immediate error checking, automatic status posting, etc.

c. The user's view of the on-line system as a "fast file clerk" to assist in performing designated tasks, leaves him with the feeling that he is in control rather than being driven by the computer. This is enhanced by the fact that the user can always resort to a QUIT function key at any time to nullify any transaction no matter how far he has progressed with it (short of actual completion).

Comments made by subjects during test and evaluation indicate that they were pleased with the responsiveness of the model system. It should be noted that the model implementation of the system provides optimum responsiveness, since 1) it operates on a dedicated computer, 2) the data files are small, 3) line speed (between terminal and computer) is 2400 bps, and 4) a high speed printer is used for hardcopy production. To the extent that any of these factors may degrade in an operational implementation, system

responsiveness will degrade accordingly. There must certainly be a response threshold which, when exceeded, would render the system unacceptable to the user, regardless of any benefits promised. While this testing made no attempt to measure user tolerance to degraded response, this is certainly an important factor to be considered in subsequent design and implementation planning.

THE MODEL APPROACH

Finally, the project staff believes that the development of the model and subsequent testing by functional personnel has shown modeling to be an effective approach to system design. Construction of a model forces system designers to a level of detail that is difficult to accomplish on paper alone. It also forces early consideration of the relationships and interdependencies of the pieces of a system.

The model proved to be an excellent vehicle for involving potential users in design discussions. Although imperfect, the model is tangible and is far more thought stimulating than a design document. By getting potential users really involved in the early stages of system design, there is a much better opportunity to shape a final system that will be responsive to user needs. The resulting system will require fewer modifications and retrofits, and should meet with wider user acceptance by acknowledging more closely in the design the real world in which it will operate.

Looking beyond the VIMS model, the following section presents some important factors in planning for development of a prototype system.

SECTION III

PROTOTYPE DEVELOPMENT PLANNING

INTRODUCTION

As noted earlier, the "prototype" system is assumed to be the first operational version installed in the field, the forerunner of more than 100 similar installations. Volume IV of this series presents the detail lying behind this summary.

Fortunately, VIMS functions today as a working data system operating on the B3500 in batch mode. This circumstance, combined with others, provides a set of practical planning constraints. Major factors are:

- The strong risks incurred in totally abandoning the B3500 as the currently successful processor of VIMS master files.
- The necessity of preserving the stability of batch VIMS software and data products during, and possibly after, transition to an on-line mode of operation. Periodic batch reports would still be needed not only for vehicle maintenance management but also as backup documentation for the on-line system.
- AFDSDC/LGTV's desire for an early on-line capability as reflected in its planning for a prototype implementation by October, 1977.
- The imminence of a major base-level ADPE (BLADPE) upgrade under auspices of the BASE-TOP and STALOG programs. Current expectations call for program planning to be essentially completed by 1977-78. Such an upgrade might involve replacement or significant enhancement of the B3500.

The method used to derive development recommendations involves definition of four basic alternatives which must be evaluated in light of several criteria of corresponding generality.

BASIC ALTERNATIVES

Figure 6 defines four alternatives for development of the on-line VIMS prototype and indicates some relationships among them. Note that each alternative must ultimately deal with the advent of new base-level ADPE. New BLADPE may take the form of a single base

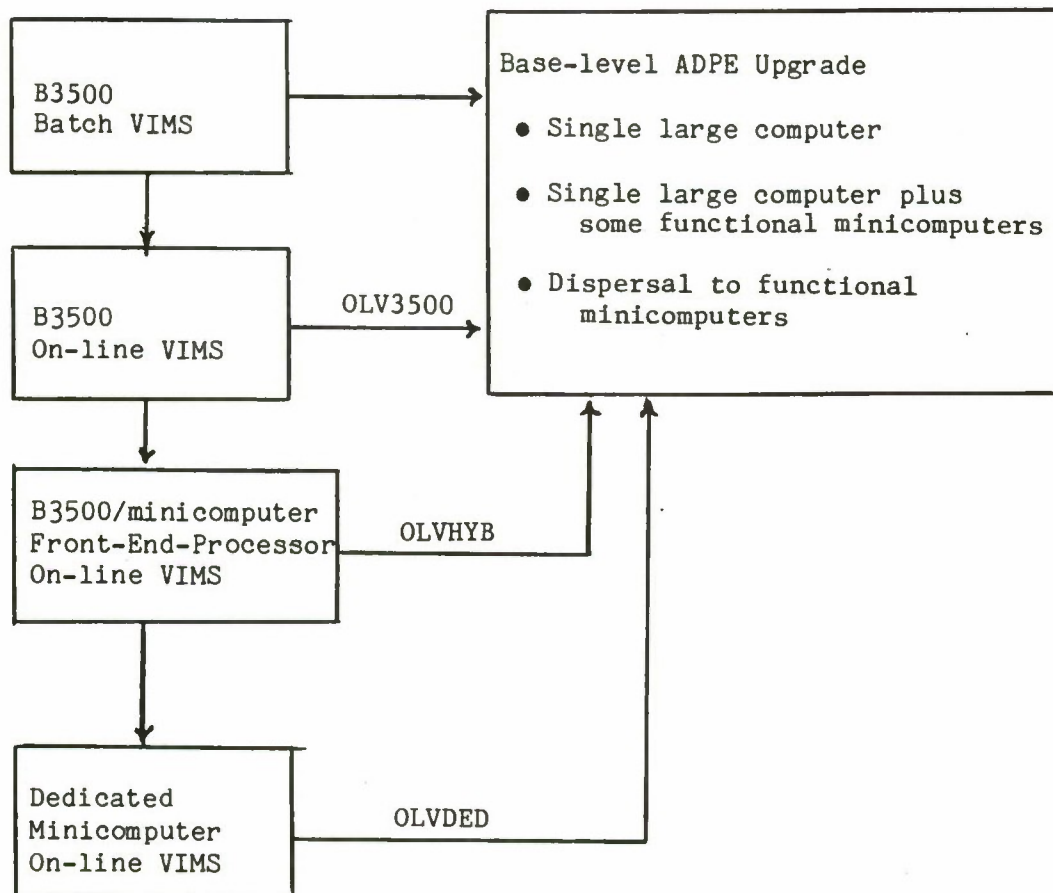


Figure 6. Prototype Development Options

computer, a central base computer augmented by functionally-oriented minicomputers, or complete dispersal of base processing to functional minis.

The first alternative calls for no action on prototype development until new BLADPE has been specified in some detail. This is essentially a non-option in view of the constraint to provide an on-line capability as soon as practically possible. However, due to unforeseen changes in funding, technical, or institutional circumstances, inaction cannot be dismissed as a possibility. The second alternative (OLV3500) calls for an on-line prototype supported solely by the B3500. The third alternative (OLVHYB) is a hybrid VIMS prototype with real-time file processing assumed by a front-end-processor (FEP) minicomputer, and the fourth (OLVDED) calls for development of the prototype on a dedicated minicomputer after a transitional implementation of OLVHYB. NOTE: The term "dedicated" refers to the equipment's relationship to on-line VIMS, not to its relationship with other base-level processors. It is presumed that any minicomputer supporting VIMS would be linked via communications to other computers to the extent that data exchange or mutual back-up requirements would dictate, and that any residual processing capacity could be used to support other elements of the logistics community.

Although OLVDED presumes an eventual transition from OLVHYB to FEP-only operation, such a transition would not take place until after adequate experience had been gained with FEP equipment, a new operating system, and with use of on-line VIMS in general. Figure 7 illustrates these transitional steps.

Note that the specified development sequence begins with an analysis of the B3500 as the prototype host computer, and that the succeeding alternative calls for retention of some file processing on the B3500. This is an essentially conservative position based on the hope that much of today's batch VIMS software could be used to support the on-line version of the system. Use of current software is highly desirable because it would

- Lessen the expense and technical risk incurred in the on-line system implementation effort,
- Reduce the possibility of damage to VIMS data bases,
- Preserve the continuity of proven batch data products, and
- Assure availability of updated VIMS master files for use in batch mode as back-up in event of on-line system failure.

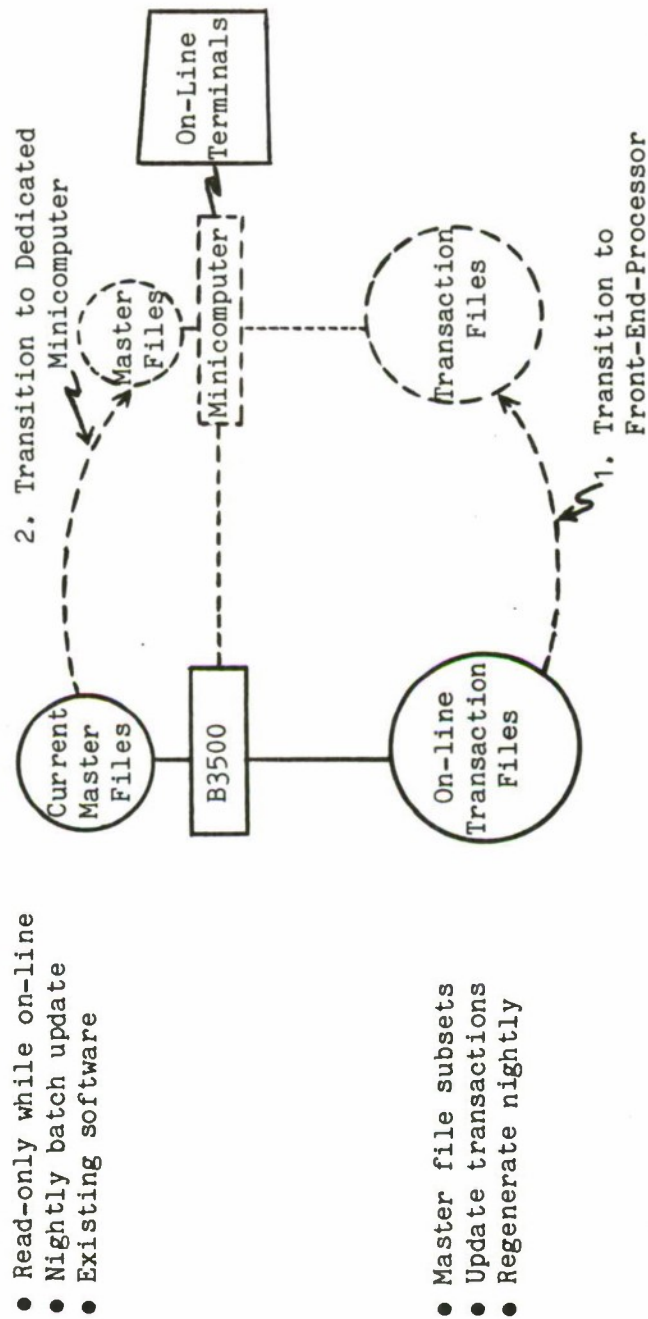


Figure 7. Prototype Design Concept

(Volume IV describes a hybrid file configuration which could permit retention of some current VIMS software.)

The arrows leading from alternative to alternative in Figure 6 indicate a progression of analysis and preliminary system design, with arrival at any one choice dependent upon evaluation of each of the preceding alternatives. Such analyses require use of evaluation criteria:

- Performance
- Cost
- Technical Risk

Whatever prototype development strategy is selected, the decision must be based on an acceptable balance of cost, performance, and technical risk, including the probable compatibility of the prototype implementation with future BLADPE.

EVALUATION CRITERIA

Performance - The performance criterion is concerned with the timeliness with which the on-line system responds to user commands. Because of the data management (as opposed to computational) orientation of on-line VIMS, system performance will equate to file access performance. Some of the time expended in file processing is keyed to storage device performance (disk latency, transfer rate). By far the greatest access delays are encountered, however, during the time an individual read/write request must wait enqueued until prior requests have been serviced. This means that, device performance factors being equal, the less software contention for storage access the faster the rate of access for any particular software system.

Cost - Volume IV presents the method used to cost the development options. As one might suspect, development program costs vary directly with the amount and complexity of new prototype software which must be written.

Technical Risk - The degree of technical risk presented by each alternative equals the extent to which its successful implementation is threatened by technical complexities and unknowns. There seem to be two separate sources of risk: difficulty of transition to BLADPE, and the relative magnitude of the new equipment and software to be incorporated in the prototype configuration.

CRITERIA APPLIED

Table II summarizes the evaluation of development options in light of the criteria defined above.

Performance

OLV3500 performance, although potentially acceptable, (and currently unknown), would be poorer than that provided by the other alternatives since VIMS software would have to compete with other B3500 users for file access facilities. (This would be the case unless VIMS were provided with a dedicated on-line storage device and data channel.) Given an FEP to process high activity files, performance of OLVHYB would be superior to that of OLV3500 since contention by other systems for storage access would occur only in the B3500. Use of a dedicated minicomputer would further reduce contention by non-VIMS software.

In the absence of a system design, the performance baseline represented by OLV3500 is currently inestimable. Once a rough design is postulated, however, the number of random access read/write operations per transaction type will be established, and these, multiplied by projected transaction volumes, can then yield total storage accesses per some unit time. Matched against current B3500 response time/storage access baselines for other on-line systems, these figures will provide some clue to probable OLV3500 performance.

Technical Risk

Development risk increases with use of unfamiliar equipment and system software, the requirement to write and test new application software, and the decision to abandon use of proven software. Hopefully, risk associated with an OLVDDED implementation would be minimized through the familiarity with new equipment and software gained during the OLVHYB experience.

Cost

Volume IV contains a detailed breakdown of costs by development option by program year.

Summarized, these are:

Table II
Evaluation of Development Options

Criteria Options	Estimated Performance	Technical Risks		Estimated Prototype Development Cost
		Prototype Development	Transition to Base-Level ADPE Upgrade	
B3500 Batch VIMS	-	-	?	-
B3500 On-line VIMS (OLV3500)	? (until pre- liminary design)	Least	?	\$.5M
B3500/Mini- computer Front-End- Processor On-line VIMS (OLVHYB)	Better	More	?	\$1.0M
Dedicated Minicomputer On-line VIMS (OLVDED)	Best	Most	?	\$1.5M

	Manpower Costs	Equipment Costs	Total Costs
OLV3500	\$ 395,200	\$ 12,000	\$ 407,200
OLVHYB	\$ 904,800	\$112,000	\$1,016,800
OLVDED	\$1,320,800	\$112,000	\$1,432,800

Conclusions

An OLV3500 prototype appears cheapest and least risky to develop, but its performance will be unknown until a preliminary system design is completed. If OLV3500 performance is eventually projected as marginal or unacceptable, then OLVHYB should be considered as a means to relieve the B3500 of most real-time file processing. This would then leave the option open to progress to OLVEDD for ease of transition to new BLADPE, or for other reasons.

Presuming OLV3500 performance is judged adequate, cost and technical risk factors must be inspected. If either of these is unacceptable, (with OLVHYB and OLVEDD offering progressively higher cost and risk), then there seems to be no choice but to await specification of new BLADPE while operating VIMS in standard batch fashion. If cost and risk are acceptable, then OLV3500 has qualified as an alternative and the decision must be made to either move ahead with an OLV3500 implementation or to qualify OLVHYB as another candidate through analysis and preliminary design.

Summarizing critical prototype development objectives, they are:

- Minimization of risk and cost by building the prototype on top of proven batch VIMS software to the extent possible.
- Preservation of the stability of the current system during transition to on-line operations.
- Smooth integration of on-line VIMS (in whatever implementation) with (whatever form of) upgraded base-level ADPE is ultimately implemented.